Joint Council on
Food and
Agricultural Sciences



# 1984 Accomplishments for Research, Extension, and Higher Education

## A Report to the Secretary of Agriculture

The Joint Council on the Food and Agricultural Sciences was established in 1977 to encourage and coordinate research, extension, and higher education activities in the food and agricultural sciences. This role was strengthened in the Agriculture and Food Act of 1981, which directed the Department to improve the planning and coordination of research, extension, and higher education within the public and private sectors and to relate the federal budget process to the overall functioning of the system.

The Joint Council initiated four reports intended to improve the overall effectiveness of the food and agricultural system.

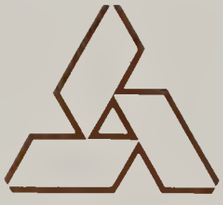
A long-term **needs assessment** (20-30 years) for food, fiber, and forest products and the research, extension, and higher education requirements to meet the identified needs. (This task was assigned to the Secretary of Agriculture in the Agriculture and Food Act of 1981. He requested the Joint Council to fulfill this responsibility). The needs assessment report was prepared and published in two separate documents. One is the *Reference Document: Needs Assessment for the Food and Agricultural Sciences* and the other is the *Summary: Needs Assessment for the Food and Agricultural Sciences.*

A **five-year plan** to reflect the coordinated goals and objectives of the research, extension, and higher education community. This report was published in 1984 and will be updated biannually.

An **annual priorities report** on research, extension, and higher education, which presents the Joint Council's priorities for the next fiscal year, the required financial support, and suggested federal, state, and private sector roles. This report will be completed by June 30 of each year.

An **annual accomplishments report** which specifies the ongoing research, extension, and higher education programs and respective accomplishments, along with expectations for the future. This report will be completed by November 30 of each year.

These four reports are inter-related although each is published separately. They constitute an overall strategic planning process which provides the food and agricultural science system with a means of assessing short-term and long-term future needs and reflecting on past accomplishments. They provide a foundation for planning the most effective and efficient means for meeting the future demands for food, fiber, and forest products. These four reports also offer a continuing mechanism by which the research, extension, and higher education programs can assess future needs.



The symbol appearing on the front cover represents the purpose of the Joint Council (i.e., to improve planning and coordination among research, extension, and higher education) and the cooperative character of the food and agricultural science system within federal, state, and private organizations.

Joint Council on Food and Agricultural Sciences

Secretariat:
Rm. 321 A, Admin. Bldg.
U.S. Department of Agriculture
Washington, D.C. 20250

November 30, 1984

Honorable John R. Block
Secretary of Agriculture
Washington, D. C. 20250

Dear Mr. Secretary:

The Joint Council on Food and Agricultural Sciences is required by Section 1407, Public Law 95-113 (as amended by Public Law 97-98) to submit to the Secretary of Agriculture an annual summary of ongoing research, extension, and teaching programs, accomplishments of those programs, and future expectations. We are pleased to submit the 1984 report to you.

This report of the past year's accomplishments of science and education in food and agriculture relates to the priorities identified by the Joint Council and to the goals enumerated in the Five Year Plan. It also describes the contributions of research, extension, and higher education both to those directly involved in the food and agriculture system and to society in general. The report emphasizes the key role played by the agricultural science and education system in our Nation's progress. Also included is a summary of the past year's activities of the Joint Council, the National Committees, and the Regional Councils.

We look forward to the opportunity of discussing this report with you.

Sincerely,

ORVILLE G. BENTLEY
Cochairman

JAMES H. ANDERSON
Cochairman

Enclosure

# 1984 Accomplishments for Research, Extension, and Higher Education

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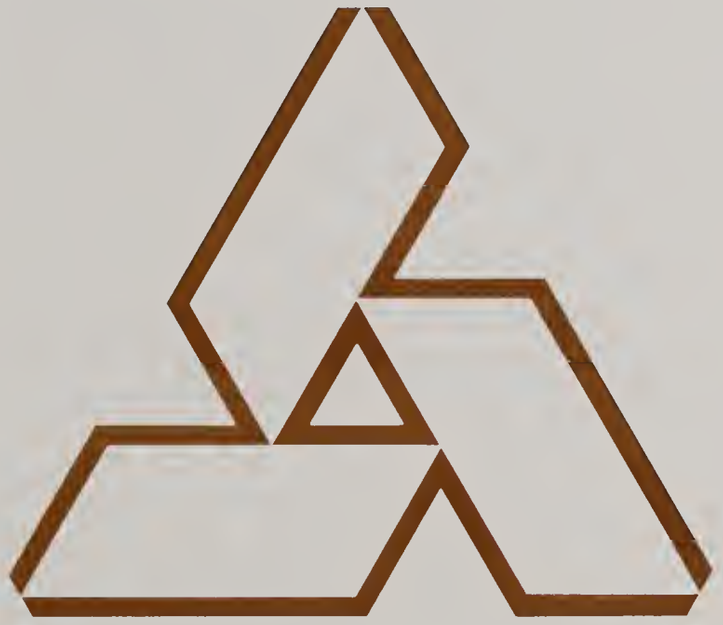

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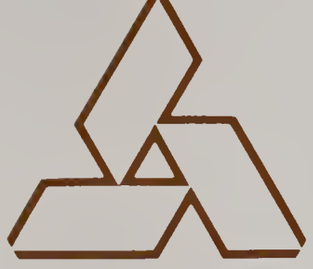
This report was prepared by the Joint Council Reports Staff:

Timothy H. Blosser, ARS, Leader
Charles B. Rumburg, CSRS
Gary C. Taylor, ERS
Roger Wilkowske, ES

Typing was done by Adrienne P. Baylor, OGPS



# Executive Summary

The Joint Council on Food and Agricultural Sciences, with inputs from its National Committees and Regional Councils, annually identifies research, extension, and higher education priorities. The Joint Council also has developed a Five Year Plan with goals and objectives for science and education. In preparing this annual Accomplishments Report, the Council considered 205 research, extension, and higher education accomplishment nominations. This report presents carefully selected achievements of the science and education system categorized under eight headings. It also includes a summary paper describing the contributions of food and agriculture science and education to the food and agricultural system and to society.

**Technology, Science, and Education—Keys to Agricultural Progress**

Agriculture justly deserves to be classified as a "high-tech" industry. The shortage of labor, food, and fiber brought on by two world wars, and the availability of technologically-trained human capital, propelled U.S. agriculture into the high-tech industry that exists today. The most crucial variable in the food equation today is the human capital which must continually strengthen and manage the highly technical and delicately integrated production, distribution, and marketing system. Maintaining the requisite agricultural expertise base—with its resulting rewards for the entire U.S. economy—requires a strong and coordinated strategy by colleges and universities, agricultural business and industry, and federal and state governments.

A key element in the federal-state partnership for research is recognition that the enormous diversity in U.S. climate and geography results in an equally diverse system of agricultural production. The extension system is an essential teaching part of the science and education system providing both a means of delivering useful information to users and a channel for relaying local needs to research and education institutions.

The significant benefits which accrue from agricultural research and extension programs include both higher income to producers and lower prices to consumers. Studies show high returns to farmers and consumers for dollars invested, ranging from 20 to 110 percent. American consumers spend an average of about 16 percent of their disposable income on food—the lowest proportion in the world.

**Research, Extension, and Teaching Accomplishments**

Many significant advances contributing to needs and priorities identified by the Joint Council were made in 1984. Several of these involved cooperation between agencies and/or states. They included:

- A multi-state study on how plants resist pest attacks.

- Interagency cooperation between ARS and Extension to facilitate technology transfer.

- Participation by research and extension in 15 states in programs to improve reproductive efficiency in farm animals.

**Scientific Expertise Development**

A top priority identified by the Joint Council was scientific expertise development. In 1984 several steps were taken to strengthen programs in higher education. These included:

- Cooperation between public and private sector leaders in food and agricultural sciences and USDA to develop programs to attract outstanding students to agriculture.

- Establishment of a Food and Agricultural Sciences National Needs Graduate Fellowship program.

- A Challenge Forum sponsored by the Secretary of Agriculture on the theme "Investing in Brainpower: Keeping U.S. Agriculture's Competitive Edge."

**Natural Resources**

High priority items which emerged during Joint Council discussions were soil productivity; water management; and forest, range, and pastureland productivity. During the past year a number of accomplishments were reported on these important items:

- Programs on efficient scheduling and use of water.

- An ARS study which demonstrated the relative benefits of conservation practices for long-term production.

- A genetic engineering study in the Northeast which gives promise of saving the chestnut tree by controlling the chestnut blight fungus disease.

**Crop Production and Protection**

Basic biotechnology research was ranked at the top of the Joint Council's FY 1985 priorities list. During 1984 several promising studies were reported which will improve plant production efficiency. These include:

- Basic studies on gene transfer and the mapping of the cauliflower mosaic virus and certain gene functions.

- Involvement of several states in the promotion of reduced tillage cropping systems.

- Maintenance of a corn gene bank supported by the North Central State Agricultural Experiment Stations and USDA.

**Animal Production and Protection**

As with plants, basic biotechnology research offers great potential for more rapid genetic improvement in farm animals. Examples of progress on genetic engineering in farm animals and other steps to improve animal production efficiency include:

- Studies in six states on mapping the location of livestock and poultry genes which control resistance to specific diseases.

- Use of monoclonal antibodies to provide information needed for development of vaccines for coccidiosis in poultry.

- Development of procedures for earlier identification of the sex of embryos, using an antibody technique.

**Processing, Marketing, and Distribution**

The Joint Council Five Year Plan emphasizes that this sector of the U.S. agricultural and food system will become increasingly important both domestically and internationally. Considerable progress was made in 1984 in several areas related to processing, marketing, and distribution. Examples include:

- Initiation of educational programs on option contracts and trading for producers and processors.

- Development of a second generation of restructured meat products that improves quality and value.

- Application of basic genetic engineering principles which will improve fermentation processes for producing various foods.

**Agricultural Policy**

The Joint Council Priority Report states the need for longer-term anticipatory policies that meet society's interests in stability for the agricultural economy. Examples of contributions by the science and education participants in 1984 included:

- Cooperative programs between USDA agencies to study the consistency between commodity programs and soil conservation.

- A USDA study on the conservation benefits of acreage-reduction programs.

- A study of world food aid needs and availabilities in 67 food-deficit developing countries.

**People and Communities**
Both the Priorities Report and the Five Year Plan identify this area as one deserving of considerable attention by science and education agencies and institutions. In 1984 progress was made on a number of programs. Examples are:

- A USDA study showing that a number of purified dietary fibers lowered blood cholesterol when added to the diet.

- Development of the Computerized Outlook Information Network (COIN) to provide timely agricultural market information.

- Use of farm financial management programs to help producers prepare and analyze cash flow and other financial statements.

**Activities of the Joint Council**
During the past year the Joint Council met four times and participated in several activities. These include:

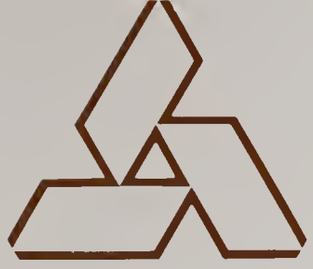
- Publication of the "Needs Assessment for the Food and Agricultural Sciences."

- Preparation and distribution of a slide/tape presentation on Needs.

- Preparation, publication, and distribution of the "Five Year Plan for the Food and Agricultural Sciences".

- Preparation, publication, and distribution of the "FY 1986 Priorities for Research, Extension, and Higher Education".

- Consideration of several topics, including the role of non-land-grant institutions, the role of the 1890 institutions and Tuskegee Institute, forestry in the future, soil and water conservation, and international dimensions of food and agricultural programs.



# I. Introduction

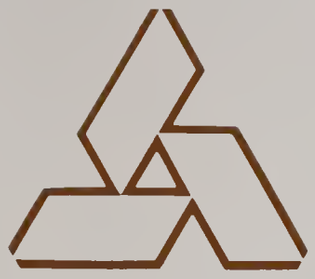
The agricultural science and education system serving U.S. citizens plays a key role in our Nation's progress. The key components of the system are higher education, research, and extension.

Today's world calls for leaders with the intellectual capacity and the ability to shape future academic and scientific innovations. We are looking at an era that may bring major changes in agricultural productivity that will affect us all—producers and consumers alike. It is imperative that our educational institutions continue to develop individuals with the ability and resourcefulness to solve the food and agricultural problems which will confront the Nation in the 21st century. Research is intimately involved with our technological progress, our competitiveness, and the quality of our life.

America's public investment in agricultural research includes the State Agricultural Experiment Stations and several agencies of the United States Department of Agriculture. The principal USDA research agencies are the Agricultural Research Service, the Forest Service, the Economic Research Service, and the Cooperative State Research Service. The research conducted includes programs for American taxpayers in their various roles as agricultural producers, consumers, wage earners, and members of society in general. The National Agricultural Library plays an important role by providing wide-ranging library and technical information services for professionals in teaching, research, and extension and in other activities important to agriculture. The wealth of information developed by research would not be used effectively without a way to transmit it to users. The Cooperative Extension system fills this role. By bringing research results to the public, extension helps agricultural producers achieve more efficient production which, coupled with improved management and marketing practices, results in greater profits. Such benefits are available to small, mid-sized, and large farms alike. However, cost-reducing technology eventually results in expanded production and lower prices. This makes necessary a continual flow of new research to maintain a profit flow for American producers. This flow of benefits from producers to consumers in the form of lower-priced food and fiber ensures that consumers get more than their dollar's worth from tax money going into producer-oriented agricultural research.

The Joint Council on Food and Agricultural Sciences comprises representatives from all components of the science and education system. A major role of the Joint Council is to provide national coordination for higher education, research, and extension in food and agriculture. The Joint Council has prepared several planning documents and reports. The Needs Assessment Report includes long-term needs for food, fiber, and forest products and the research, extension, and higher education requirements for meeting the identified needs. Two Joint Council reports—The Five Year Plan and the

FY 1985 Priorities Report—provide guides for measuring progress toward the long-term needs. The FY 1985 Priorities and the subject-matter and special categories in the Five Year Plan are shown in Appendix 1. This Accomplishments Report describes progress toward meeting the goals identified in the other reports. Continued identification of the top priorities in food and agriculture and the subsequent solution of the problems identified will be an important factor in determining our leadership role among nations and the quality of our life in the future.



## II. Technology, Science, and Education—Keys to Agricultural Progress

Agriculture has emerged as one of America's "high-tech" industries. Its high capital-to-labor ratio and high rate of technological change clearly put it in that category. But agriculture's entry into the high-tech arena is a relatively recent event—an 11:00 news flash in the story of mankind. How has this revolution come to man's oldest culture?

Only a few thousand years ago, our predecessors subsisted largely as hunters and gatherers, and land was the only input into agriculture. The distribution and size of early cultures was determined by the natural fertility of the land and the hospitality of the climate. The appearance and disappearance of some early cultures attests to the capriciousness of natural provisions.

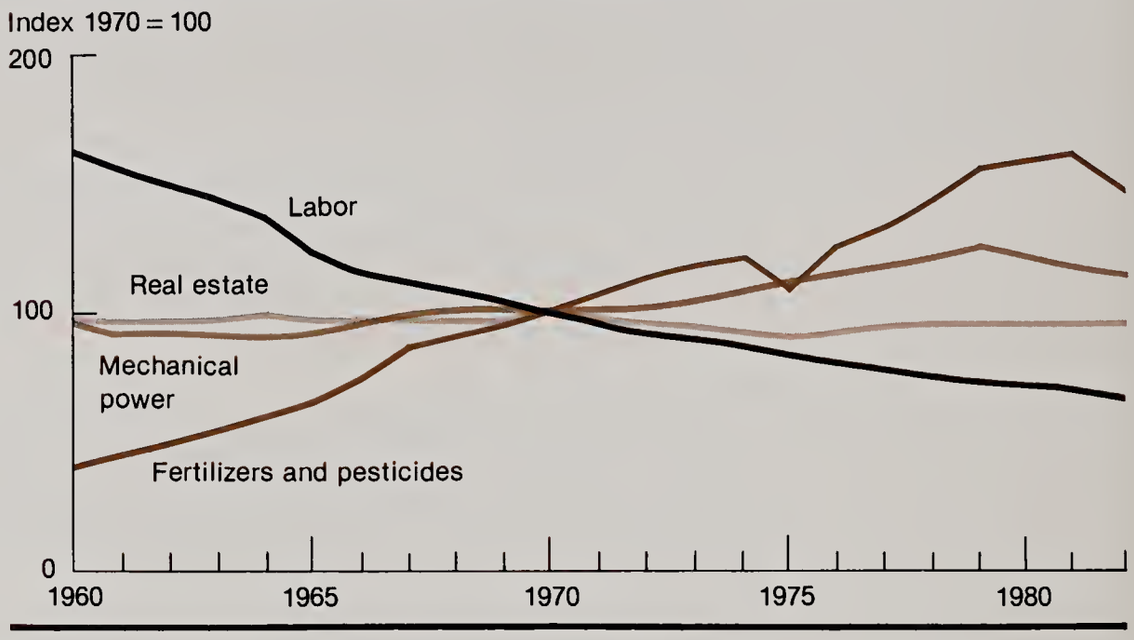
The application of technical methods to solve the practical problems of insuring a stable food supply slowly and inconsistently led to the domestication of plants and animals. Stable food supplies led to permanent settlements and the founding of husbandry as the basic art of civilization. Labor, in the economic sense, was established as the second input into food production.

The next major change in agriculture was the introduction of draft animals. As industrial materials such as steel became widely available, Europe and the United States developed labor-saving horse-powered farm machinery. During the American Civil War, the foreign and domestic demand for food sent prices up sharply. That, plus the shortage of labor, provided the driving force in the conversion to horse-powered agriculture in the United States. Thus, the substitution of horse power, and later mechanical power, for labor became a management option, making capital the third input into agriculture.

The scientific basis for agricultural production began with early scientific work in Europe which spread to the United States and continued to grow. Agricultural science in the United States advanced significantly during the Civil War with the establishment of the U.S. Department of Agriculture and the land-grant universities. Knowledge resulting from scientific studies paved the way for applying the technologies of soil improvement, pest control (chemicals), and improved varieties. Armed with this knowledge, management could now achieve more production from the same amount of land, thus substituting capital for land as well as for labor.

The shortage of labor, food, and fiber brought on by two world wars, and the availability of technologically-trained people, propelled U.S. agriculture into becoming the high-tech industry that it is today. The changes that have occurred in agriculture are primarily changes in the relative proportions of land, labor, and capital—changes that are possible because of technology and because of the substitutability among these resources. But this substitution is an extremely complex decisionmaking process requiring managers with skill in both technical and financial matters. This brings us to the fourth resource essential to modern agriculture—human capital.

**Changing Mix of Inputs Used in Farm Production**




In fact, the most critical variable in the food equation today is the human capital which must continually strengthen and manage the highly technical and delicately integrated production, distribution, and marketing system. The heartbeat of American agriculture is its people. They are engaged in diverse and dynamic agricultural positions in business, communication, science, government services, education, production, processing, and marketing. To fill these positions requires an educational system which can respond quickly and effectively to society's needs.

## The Science and Education System

The United States is fortunate to have a unique system of agricultural research and education which has proven its ability to fulfill this critical responsibility. It is a three-faceted system, consisting of higher education, research, and extension of knowledge to the public.

One of the strengths of the U.S. food and agriculture science and education system is its diversity. Colleges and universities with curricula in the food and agricultural sciences are found in every state. The **higher education** system includes community colleges, land-grant universities, non-land-grant public universities and colleges, and privately financed institutions of higher education. Each has contributed in its own unique way to enhancing the productivity and efficiency of the food and agricultural system.

**Research** related to agricultural production and marketing is conducted by the state agricultural experiment stations of land-grant universities, by public non-land-grant institutions, by various agencies of the federal government, and by private industry.

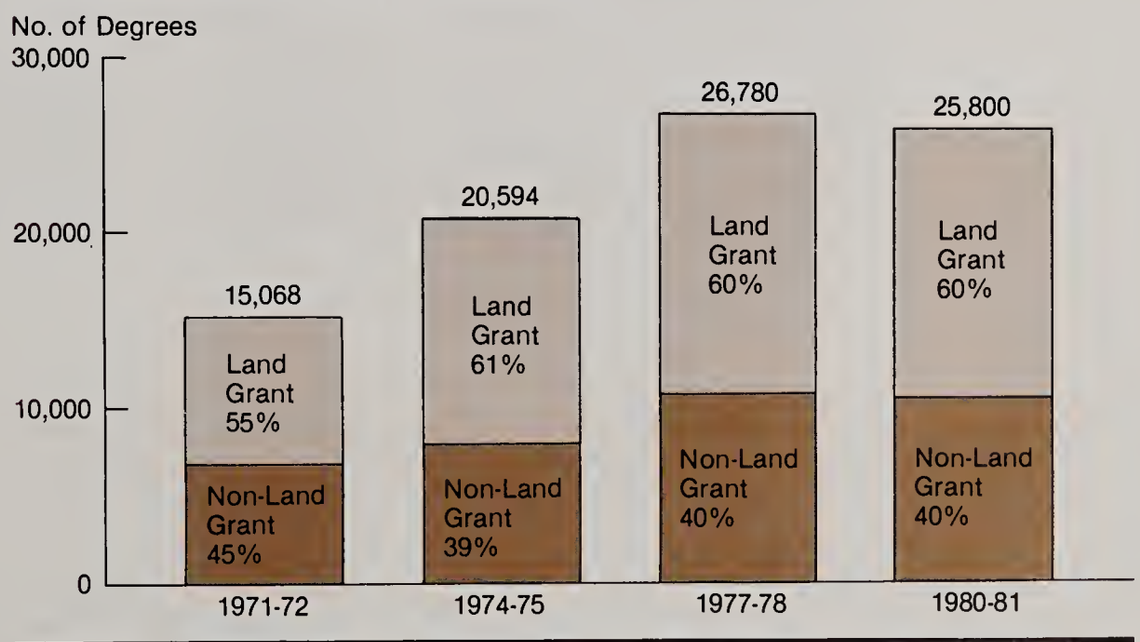
Research findings are transmitted to ultimate users by an **extension** education system unique to the United States. Because this extension system is organized at levels of government starting at the county level, it is indeed a grassroots organization.

The teaching, research, and extension functions come together at land-grant universities. Many professionals at these institutions have academic appointments involving two or more of these functions. These same people have many contacts with county extension agents; agricultural producers and the businesses which serve them; commodity associations; and local, regional, and state agencies and associations. These contacts furnish excellent communications bridges which are important to the continued pertinence of science and education programs.

**Higher Education and Agricultural Progress**

The Nation's agricultural colleges are the predominant producers of scientists, professionals, and managers with agricultural expertise. They train about 65 percent of the 59,000 university and college graduates required annually to fill scientific, professional, and managerial positions in the food and agricultural sciences. Seventy land-grant and 65 non-land-grant institutions offer baccalaureate and/or graduate programs in agriculture and natural resources. Their curricula range widely to embrace high-technology agriculture and intensive capital management. They encompass many subjects which are far different from the stereotyped images of 'production-based" agriculture.

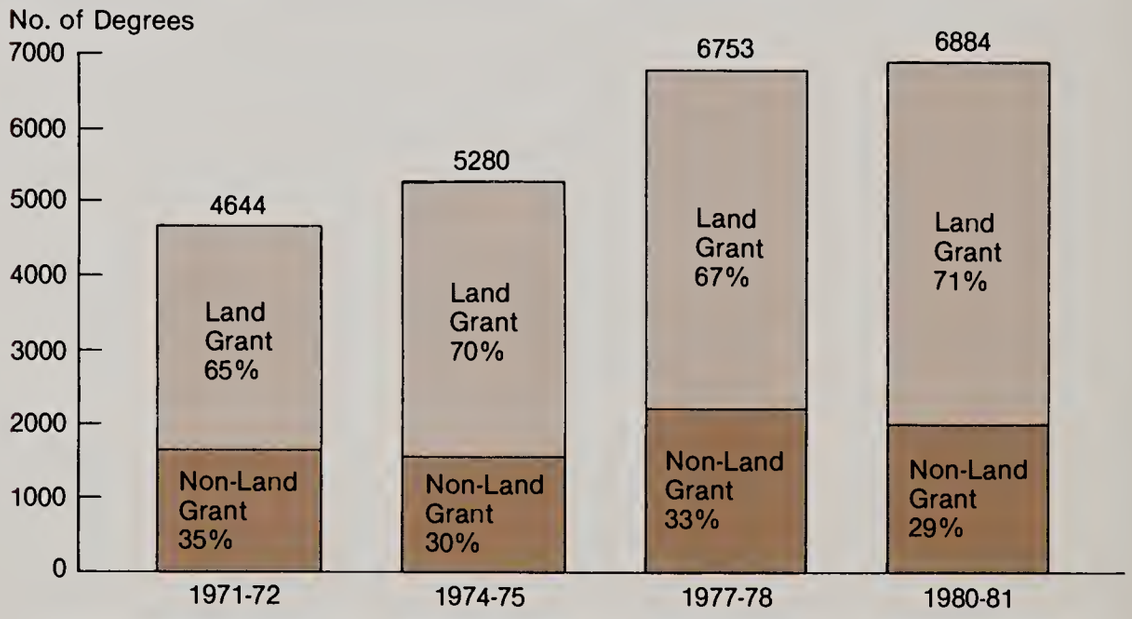
**Bachelor of Science Degrees · Agriculture**



Skills and aptitudes needed for the development of productive agricultural professionals are the same as those required for other scientific and technical disciplines. For this reason, agriculture must compete for the limited number of students who acquire adequate scientific preparation in the secondary schools.

Graduate training of prospective scientists and educators is an exceedingly important element in agricultural progress. Graduate education and research go hand in hand and are the bedrock of every important industry. Our graduate schools are the training grounds for future agricultural scientists and educators and are of inestimable value to our Nation. The continued output by our universities of young scientists and teachers conversant with the most advanced approaches and techniques for training students and solving complex scientific problems will assure our continued preeminence in food and agricultural production.

**Master of Science and Doctor of Philosophy Degrees - Agriculture**




The ever-growing need for agricultural expertise in the world's less developed countries depends heavily on the U.S. capacity to provide the education to deal with this deficiency. About 36 percent of the 1981 U.S. doctoral degrees in the food and agricultural sciences were awarded to people from other nations.

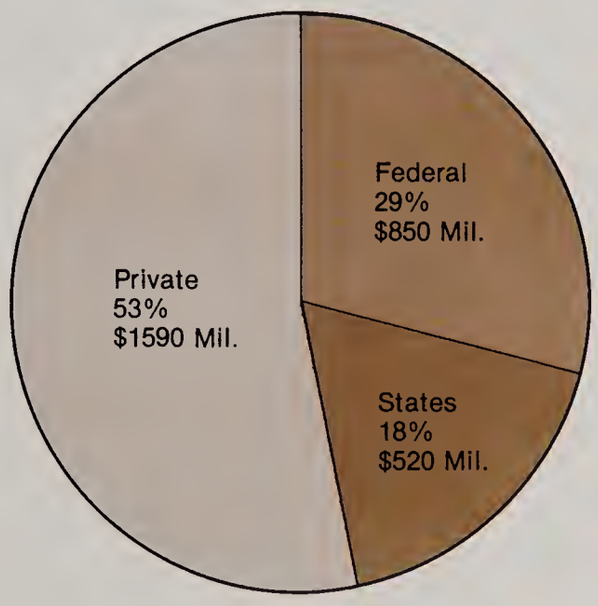
Maintaining the requisite agricultural expertise base—with its resulting rewards for the entire U.S. economy—requires a strong and coordinated strategy by colleges and universities, agricultural business and industry, and federal and state governments.

**Research and Agricultural Progress**

Several groups fund and perform research and development for agriculture. The **private sector** provides the major share of the funding for developing processes and products that yield a profit in the marketplace. **Public** research funds are concentrated in the biological sciences and in technologies that do not attract private industry because profits are not easily captured. Public funds also support a larger proportion of long-term, high-risk research than do funds provided by industry.

Through joint federal-state funding, state agricultural experiment stations are linked to federal research agencies in collaborative and complementary programs of research to meet local, regional, and national goals. The key element in the federal-state partnership is recognition that the enormous diversity in U.S. climate and geography results in equally diverse systems of agricultural production. The state agricultural experiment stations are committed to meeting agricultural needs within their own states, thereby meeting the challenge of diversity.

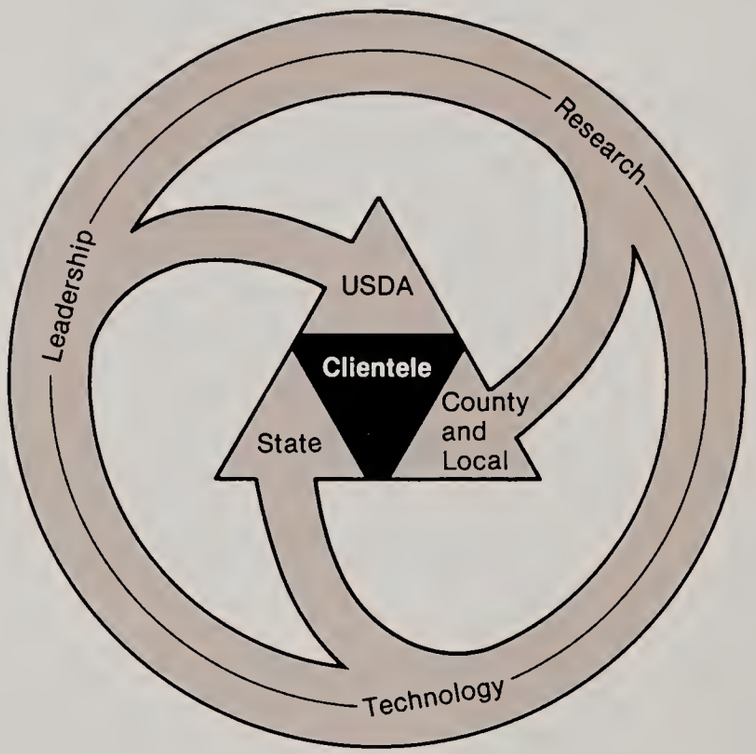
**Funding of Agricultural Research · 1982**




**The Extension System—A Catalyst for Change**

The mission of the Cooperative Extension Service is to improve American agriculture, conserve natural resources, strengthen family and community life, and develop leadership capabilities in youth and adults nationwide. A three-way partnership of federal, state, and local governments carries out this mission by disseminating and encouraging the application of research-based knowledge and technology.

**Cooperative Extension Service Basic Mission and Partnerships**




At the local level, people receive information, training, and assistance from county agricultural agents, 4-H agents, home economists, and others, depending on local needs. State extension staffs at land-grant universities provide local staffs a link with researchers and specialists. The federal Extension staff at the U.S. Department of Agriculture provides nationwide leadership and coordination.

More than 3,000 Cooperative Extension offices exist throughout the United States, and the professional Extension staff numbers nearly 17,000. In addition, 5,500 paraprofessionals and over 1.5 million volunteer leaders, trained and supervised by the Cooperative Extension staff, help extend programs. The Cooperative Extension Service provides:

—delivery of localized and useful information to meet the needs of clients in diverse geographic areas, and

—a way to relay local needs and problems back to research and teaching institutions, so that the entire system can be responsive to the needs of society.

## Science and Education—Benefits to Society

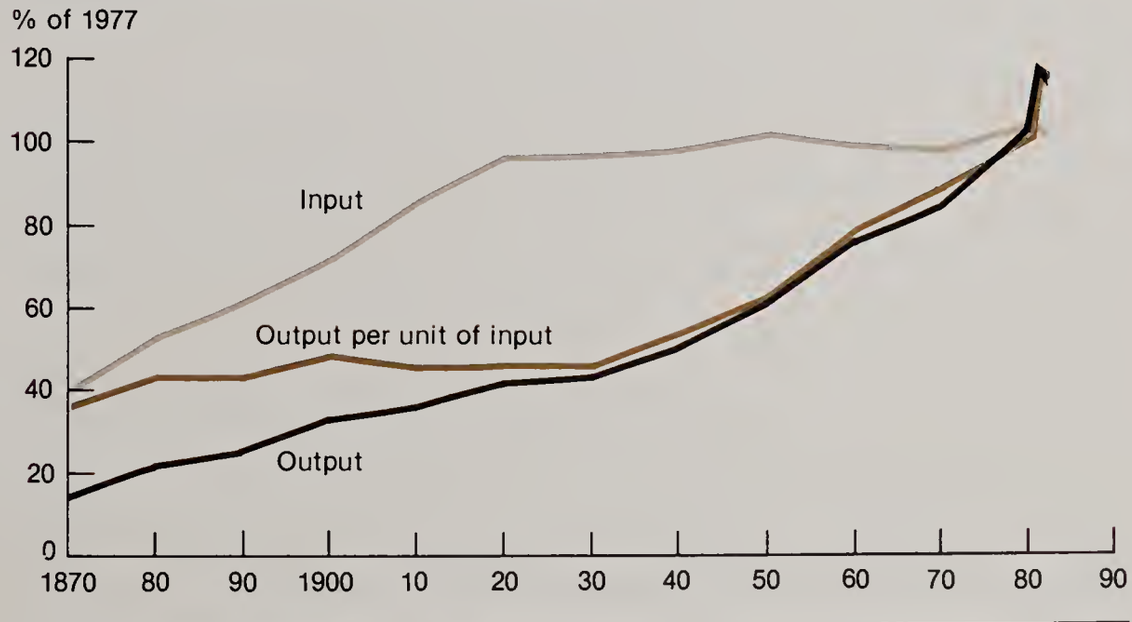
Agricultural research and extension activities are supported by general tax revenues at federal, state, and local government levels. What is being accomplished with this portion of the Nation's tax money? Are research and extension providing an adequate return for the taxpayers' investment? Who benefits from agricultural research and education? Does one segment of the population benefit more than others? Do the disadvantaged share in consumer benefits?

### Some Accomplishments of Science-Based Agriculture

The evolution of a science-based agriculture has led to many spectacular changes. Two examples should provide an illustration of the impact of this evolution on the United States.

Corn for grain—our number one crop—is one illustration of technological progress. From 1929 to 1933, before the commercial use of hybrids, corn yields averaged 24 bushels of grain per acre. In 1958, hybrid corn varieties accounted for 94 percent of planted corn acreage and U.S. average corn yields first exceeded 50 bushels per acre. Twenty years later, in 1978, the U.S. average yield broke the 100-bushel mark. These yield increases were made possible by genetic improvements in the plants which permitted intensive management practices (high plant populations, better drainage and moisture control, and higher levels of fertilizer and pesticide use); and the reduction of harvest losses resulting from improved harvest and drying technology. The farm prices of corn and other major plant commodities—wheat, soybeans, and cotton—when adjusted for general inflation, are lower now than in the late 1960's before the worldwide inflationary spiral began.

**Farm Productivity, United States, 1870 to 1980**



Pervasive technological change has altered the entire character of the broiler chicken industry. Changes have occurred in housing, feeding and waste handling systems, nutrition, disease-control methods, and selective breeding for growth rate and feed conversion efficiency. Other innovations, such as production contracts, vertical coordination, and large-scale infusions of credit from feed suppliers, have accompanied the technological changes. The size of broiler farms has increased rapidly, while the total number of broiler farms has decreased substantially. The real, inflation-adjusted price of broilers has fallen dramatically during the transformation of the industry. Supplies of broiler meat have increased rapidly, and the actual farm prices of broilers have fallen from $0.36 per liveweight pound in 1948 to less than $0.27 in 1982. The price drop is surprising considering the substantial increases in prices of other commodities which have occurred during this period. In spite of lower farm prices, a viable, profitable broiler industry exists because the application of research findings have lowered production costs and increased broiler production efficiency.

**Benefits From Agricultural Research and Extension**

Since the 1950's, university researchers have carried out a number of economic studies to measure the benefits of agricultural research and extension programs. These researchers have used different measurement techniques; evaluated different commodities and programs; and examined results in different time periods. All the studies have shown significant benefits, including both higher incomes to producers and lower prices to consumers.

All the studies demonstrated high returns to farmers and consumers per dollar invested. One group of 20 analyses found annual rates of return of 20 to 110 percent. Nearly all of the rates of return were well above the 10 to 15 percent after inflation that business firms consider to be adequate for profitable investments. These studies typically do not consider impacts on the costs of federal commodity programs.

**How the Benefits Are Distributed**

The development of new technology affects a complex system consisting of farmers, consumers, and a large number of farm supply, processing, marketing, and distribution firms, including local supermarkets. Fortunately, this is a flexible and competitive system generally characterized by good management, high volumes, and low profits per unit. It rapidly adjusts to changes in prices and costs.

Farmers sell at prices established by supply and demand factors in the market. Since they cannot control prices, they are constantly searching for new ways to reduce costs per unit of production. The benefits of new technology go first to the early adopters who are the first to use the new methods to reduce their costs and increase their profits. But as more and more farmers adopt the technology, their increased production increases supply and lowers prices in the market, so they receive no further benefits. Then, it is the consumers who benefit.

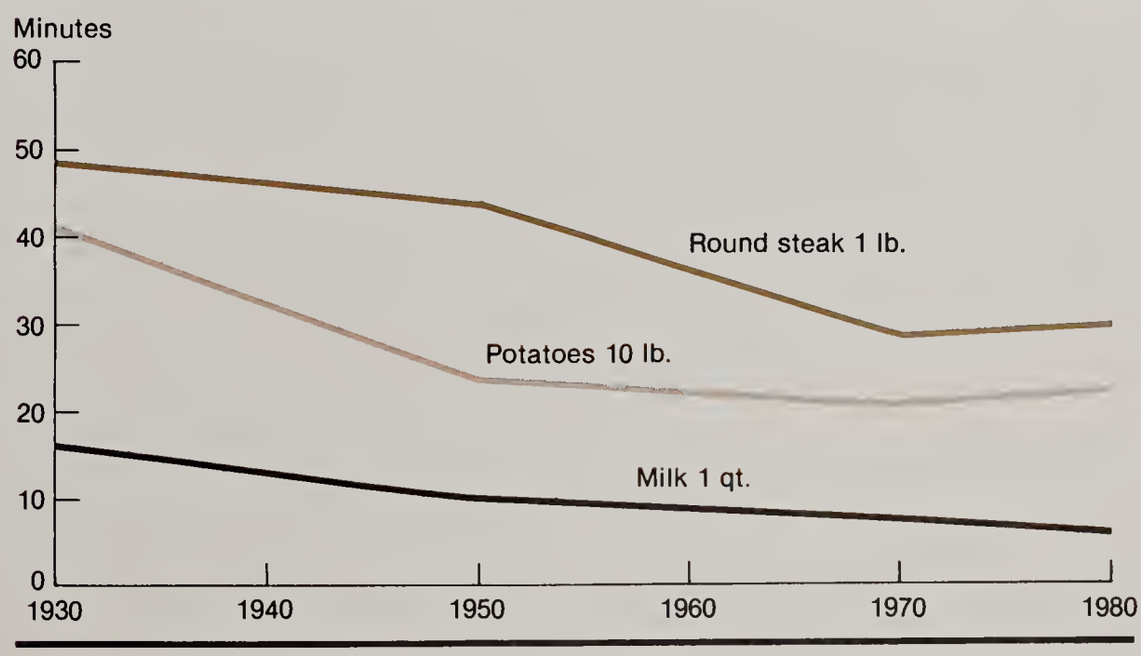
In the case of exports, on the other hand, U.S. producers can often retain some of the benefits of the new agricultural technology that they have adopted. In the domestic market, demand is inelastic, meaning that sales volume does not increase much as a result of lower prices. Lower prices in the export market, however, mean that the foreign customers may buy more of the product to improve their diets or may buy from the United States instead of from other countries whose prices are higher.

Forest products compete with other materials in both domestic and foreign markets. Lumber, for example, competes with steel, cement, and other building materials. In the packaging field, paper competes with glass and plastics. Because there is room to expand the market, research leading to lower prices for forest products means higher sales volume for producers and lower prices for consumers.

**Consumers—the Ultimate Beneficiaries**

It is one of agriculture's best-kept secrets that agricultural research and extension programs which increase productivity primarily benefit U.S. consumers by bringing about lower prices relative to incomes. American consumers spend an average of only 16 percent of their disposable income on food. This is the lowest proportion in the world, and it has moved steadily downward for more than 40 years. The agricultural science and education system is a major factor in this accomplishment. Of course, lower income groups must spend higher proportions of their income on food, but the price-reducing influence of new agricultural technology is relatively more important to them than to more affluent consumers.

**Cost of Food Items in Minutes of Work**



Another method of measurement is to consider benefits returned per dollar of taxes paid. A recent analysis by the Congressional Office of Technology Assessment demonstrated that agricultural research resulted in relatively greater net benefits to low-income consumers than to high-income consumers. The average benefits to families with incomes of more than $20,000 were nearly twice as high ($31) as to families with incomes under $5,000 ($16). But if the taxes paid by consumers to support agricultural research are apportioned among income classes, the ratio of benefits to tax payments is 10 times higher for the lower income group.

It is clear, then, that our food and agriculture science and education system is very important to all of us. Adopting new technology is of paramount importance to improving the efficiency of production of food, fiber, and forest products and increasing the profitability of farm enterprises. The system plays a significant role in maintaining adequate amounts of high quality products at affordable prices, and it contributes to our competitiveness in the world marketplace. Finally, it is a good buy—investments in agricultural research, extension, and higher education pay excellent dividends. Maintaining a healthy, vigorous, progressive system is a high priority for our country both now and in the future.

## Multiple Functions, Agencies, States

The science and education segment of the food and agricultural system includes three functions—research, teaching, and extension. The people who perform these functions are located in all states and in several federal agencies. Frequently, in solving important problems, the participants need to cooperate to achieve the goal. Several examples of such cooperation are listed in this section.

**ARS Speeds Adoption of Research Results Via Computer Link With Extension:** Research results produced by the Agricultural Research Service (ARS) and used in Extension education programs are an important factor in improving the productivity of U.S. food and agriculture.

To speed transfer and adoption of research results, the Agricultural Research Service, the federal Extension Service, and the Cooperative Extension Service instituted a pilot project in six states to test direct linkage between the ARS and ES computer systems in June 1984. The system also provides feedback on research needs from Extension specialists to ARS researchers. If this project is successful, the plan will be adopted in all states in 1985.

**Reducing Losses Caused by Wildlife:** The Nebraska Cooperative Extension Service, in cooperation with the Environmental Protection Agency and the Great Plains Agricultural Council, has produced a *Handbook on Wildlife Damage Prevention and Control*. More than 40 authors made voluntary contributions to the book. It will save many hours of reference time and will help managers and users significantly reduce losses to crops, livestock, forestry, and other resources caused by wildlife. The Natural Resources Council of America recognized the handbook with an "outstanding publication" award.

**How Plants Resist Pest Attacks:** Plants do not react passively when attacked by pests. Recent experiment station research in California, Washington, Montana, and Kentucky has shown that plants actively respond biochemically to insect attack. When wounded by insects, potatoes produce two biologically active proteinase inhibitors which are detectable in adjacent unwounded leaves within 4 hours. Similarly, tomatoes produce compounds that are active antibiotic agents against tomato fruitworm and beet armyworm. Western wheatgrass, when under stress, experiences an inhibition of deoxyribonucleic acid synthesis. As the rangeland grasshopper feeds upon this stressed grass, it produces fewer viable eggs. Ponderosa pine produces pitch tubes when attacked by the red turpentine beetle. Trees with pitch tubes have a greater probability of dying. Identifying "at risk" trees can permit cutting before they die and thus provide more usable timber. Even corn in storage exhibits biochemical resistance to the maize weevil through specific chemicals in the kernel pericarp.

**Farm Animal Reproductive Efficiency Improved:** Significant progress has been made in improving the reproduction efficiency of farm animals. The most effective programs are "integrated"—that is, they deal with several aspects of an operation at once—and they are targeted to actual management situations and specific problems of producers. Fifteen States now have Integrated Reproduction Management (IRM) programs in dairy, beef, swine, sheep, or poultry. Because the IRM programs address all components of livestock systems, they are more effective than traditional single-component educational programs. These programs use the combined expertise of subject-matter specialists in extension, research, and industry to solve problems.

A cooperative agreement between the National Agricultural Library and West Virginia University supports the development of an expert system in IRM. An IRM dairy program in northern New York increased net income of participants by $4,000 per farm. In Georgia, a poultry IRM project saved the Georgia broiler industry $250,000, and in Idaho, IRM increased net income of cow-calf producers by $3 million.

**Flood Victims Aided:** Natural disasters occur with disturbing frequency in the United States. Afterwards, USDA teams make recommendations for federal action. Within the past year, floods have caused considerable damage in the North Central United States. Extension agents and specialists in the states affected—South Dakota, Iowa, Missouri, and Nebraska—met with farmers. They explained options and recommended alternative crops to plant when seedings of usual crops were delayed or destroyed by flooding. They also examined homes, furnishings, and equipment damaged by the floodwaters. The Extension Service participates in an interagency committee that meets regularly to develop plans for facing various types of national emergencies.

**Remote Sensing Improves Land-Use Planning:** Researchers at Michigan State University are developing better land and climate information for land-use planning by using computers to help analyze data relayed by satellites. The satellite data, when analyzed with other computerized information (on soils, geology, etc.) is used to determine land suitability ratings for such things as forest management and oil and gas pipeline routing and to document coastal marsh erosion. The pattern and rate of nocturnal cooling of Michigan's land mass is also being determined through computer analysis of weather satellite data for eventual use in fruit-crop freeze forecasting and agricultural site suitability rating.

## Scientific Expertise Development

One of the priorities identified by the Joint Council in the FY 1985 report was scientific expertise development. This is one of the top priorities because of declining college enrollments in agriculture and because of the urgent need for high quality scientists, technicians, and entrepreneurs. The Five Year Plan for the Food and Agricultural Sciences emphasizes as a goal the need to "strengthen higher education programs in the food and agricultural sciences in order to train scientists and professionals at the forefront of knowledge and technology."

**National Network Initiated To Attract Top Students to Agriculture:** More high quality students must prepare for scientific careers in priority food and agricultural disciplines if we are to have a highly efficient food system in the 21st century. USDA's Higher Education Programs office has coordinated the establishment of a national program to attract outstanding students to agriculture.

The objectives of this program are to: help high school science teachers emphasize science in agriculture; conduct regional and national "Focus on Science in Agriculture" symposia involving agricultural scientists, outstanding high school students and teachers, and university agricultural faculty; provide special incentives to outstanding high school students who have demonstrated excellence in the food and agricultural sciences; disseminate high quality materials which focus attention upon careers in the food and agricultural sciences; and enhance mechanisms for placing outstanding high school science students in research programs conducted by private or public sector agricultural scientists.

**"National Needs" Graduate Fellowships Established:** The Higher Education Programs office initiated a new program of Food and Agricultural Sciences National Needs Graduate Fellowships in 1984. The program represents an investment strategy to augment the development of agricultural scientists and professionals. It is designed to attract highly capable young scholars to prepare for key scientific and professional roles in areas with particularly critical shortages of expertise—biotechnology, food and agricultural marketing, agricultural engineering (including soil and water conservation and management), and food science/human nutrition. The program supported the recruitment and first year of training for some 300 graduate students in these key disciplines. Ninety percent of the $5 million supported doctoral students, and 10 percent went to master's students.

**Secretary's Challenge Forum:** Secretary of Agriculture John R. Block recently sponsored a Challenge Forum on "Investing in Brainpower: Keeping U.S. Agriculture's Competitive Edge." Representatives of universities, industries, and government agencies met in January 1984 to consider the development of expertise in the food and agricultural sciences.

As a result of the Forum, industry and university representatives have expressed a strong interest in working cooperatively to: change agriculture's image to reflect modern realities; market agriculture as an arena of attractive, challenging careers; recruit top high school students for careers in the food and agricultural sciences; periodically examine, evaluate, and propose ways to revitalize agricultural college curricula to keep them relevant; encourage and support faculty development in order to maintain "cutting edge" academic programs; expose undergraduate students to research laboratories to attract them into the food and agricultural sciences; promote scientist exchanges between industry, academia, and government; and expand student internship opportunities.

**National Assessment of College and University Faculty in the Food and Agricultural Sciences:** Colleges and universities have difficulty hiring and retaining qualified faculty in the food and agricultural sciences. In FY 1983/84, USDA's Higher Education Programs office obtained information on this problem through a nationwide *Survey of College and University Faculty in Agriculture and Natural Resources, Forestry, and Home Economics.*

Preliminary findings indicate that a normal 14 percent of the faculty in the 1862 land-grant colleges of agriculture will retire in the next 5 years. However, projected retirements in many specializations are much higher (dairy processing, 28 percent; animal breeding/genetics, 26.7 percent; soil science, 23.4 percent; plant breeding/genetics, 20.6 percent). When current vacancies are considered, agricultural economics, agricultural engineering, and food science surface as the disciplines with the most critical shortages of faculty. A full report will be available within the next year.

## Natural Resources

Three of the priorities identified by the Joint Council for FY 1985 fall in the Natural Resources category. These include "Sustaining Soil Productivity", "Water Management", and "Forest, Range, and Pastureland Productivity Enhancement". The Five Year Plan categorizes these under two headings—"Soil, Water, and Air" and "Forest, Range, and Wildlife." The Priorities Report emphasizes the importance of reducing soil erosion—a cost to the landowner and society—and improving water use efficiency, particularly in irrigated areas. The Report also emphasizes the importance of managing and using the Nation's forest, range, and pasturelands wisely since they are the dominant United States land-use categories.

**Reduced Tillage Changes Soil Properties and Plant Growth:** North Dakota experiment station scientists have found changes in soil properties after 5 years of no-tillage farming. For example, the surface soil has increased in bulk density and compaction. This may account for a slower growth rate of grain plants in some years. Organic matter, total nitrogen, phosphorus, and potassium have accumulated near the soil surface without tillage. Soil aggregation increased, thus reducing the erosion hazard and minimizing soil crusting during plant emergence. Early plant growth rate is greater because the no-tillage method helps the soil retain moisture and avoid extreme fluctuation in soil temperatures. Yields under reduced tillage are comparable to those of conventionally tilled soils.

**Conservation Practices Improve Production:** An ARS study has demonstrated the relative benefits of conservation practices for long-term production. An operational NTRM (nitrogen, tillage, residue management) research model was used in a drought study of the Great Plains area. It simulated grain sorghum and wheat growth for a 100-year period under several different management practices designed to control drought stress. The resulting predictions of the relative impacts of the proposed management practices are in a form suitable for use as guidelines to farm operators.

**Water Use Management Improved:** Extension programs that promote efficient scheduling and use of water are being conducted in several States. These include irrigation water management in Kansas; a Wyoming 'checkbook" method that considers precipitation, temperature, and crop requirements in water use; measurement of groundwater pumped in Arizona; and more efficient use of drip irrigation methods in California. In Colorado, water use efficiency is being promoted through voluntary basinwide water management. Basinwide computer models have been developed to evaluate water use, proposed reservoirs, reservoir sites, and water exchanges.

**Management and Conservation of Soil and Water Resources Encouraged:** In order to encourage improved management and conservation of soil and water resources, Extension has focused on several important issues. These include production of a publication entitled "The Soil Vanishes" by the Illinois Cooperative Extension Service. This was distributed to 240,000 farmers. A conference on groundwater was sponsored by the Northeastern Regional Center. This subject was also discussed in seminars conducted in New York and Florida. A cooperative effort in Colorado resulted in salinity reduction. A Massachusetts program on community water supplies helped 16 communities increase water available for domestic and industrial use.

**Applying Existing Knowledge to Rangeland Management:** Managing the rangelands of the Great Basin has been hampered because not enough is known about them, and because what is known has not been fully applied. In an effort to make better use of what is already known about rangelands, the Forest Service's Intermountain Station published a summary paper entitled, "Managing Intermountain Rangeland-Sagebrush-Grass Ranges." Besides summarizing methods of rehabilitating, converting, and managing sagebrush range, it also serves as a manager's reference and guide to research results. This first-in-a-series of summary publications digests the most useful knowledge from more than 1,250 earlier papers.

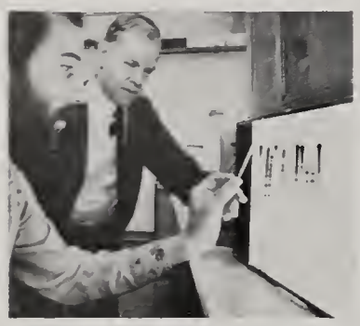
**Saving the Chestnut Tree Through Genetic Engineering:** The American chestnut, once the premier hardwood forest tree of the Eastern United States, was virtually eliminated 5 decades ago by the chestnut blight fungus disease. Chestnut extinction has been avoided through blight canker remission. This, in turn, is due to presence of fungus strains that have lost the ability to kill the tree.

A northeastern regional research project begun in 1981 demonstrated that the reduction in virulence was due to presence of a chemical known as double-stranded ribonucleic acid (dsRNA) and probably also involved virus-like particles in the fungus. Use of new biotechnology tools has permitted manipulation of the dsRNA to change lethal fungus strains to benign ones. Although many complex phenomena remain to be worked out, this research has great potential to help preserve the American chestnut, as well as to provide new knowledge of genetic engineering.

**Increasing Forage Production on Range:** Mechanical range renovation increased forage production on a shortgrass range site in southeastern Wyoming. The renovation techniques, developed by ARS scientists, result in more effective use of precipitation by increasing infiltration. The renovation treatments resulted in a two-fold increase in the livestock carrying capacity of the range site. The economic benefits gained in forage production will pay for the renovation costs in about 4 years. Single ripping was the most effective mechanical treatment for improving grass on the site.

## Crop Production and Protection

Basic biotechnology research was ranked at the top of the Joint Council's FY 1985 Priorities list, and the importance of genetics and cellular biology were emphasized. The Five Year Plan stated the dual importance of plant potential and management practices and indicated that the high cost of farm production relative to income may be the most urgent problem facing U.S. agriculture.



**Advances in Genetic Engineering of Plant Viruses:** The discovery of DNA plant viruses by scientists at the University of California at Davis was a milestone in research progress in plant pathology. Continued research on the molecular biology of Caulimo-viruses has attracted worldwide attention, since certain strains of cauliflower mosaic virus (CMV) can conjugate with bacterial plasmids and be cloned in *Escherichia coli.* These findings have resulted in the mapping of the CMV genome and certain gene functions. It has also led to the use of mild or non-symptom-causing strains of CMV as vehicles for gene vectors in higher plants. This system offers promise for gene transfer and genetic improvement of crop plants. California scientists are currently studying the genes which affect host compatibility in order to extend the host range of these viruses.

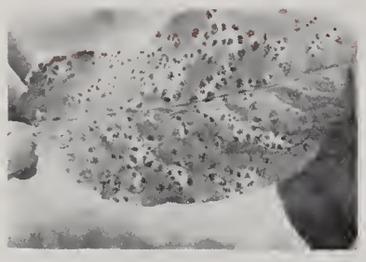
**Reduced Tillage Cropping Systems Promoted:** Producers receive information on reduced tillage systems through seminars, tours, and demonstrations. Extension programs conducted during the past year include: a statewide coordinated education effort in Delaware that has resulted in yield increases and substantial fuel savings; training in equipment operation in Rhode Island; conservation tillage seminars and field days in Indiana that promoted no-till planting systems; soil erosion control systems in Iowa that resulted in changed management practices by up to 50 percent of the participants; conservation cropping practices in Kansas that affected about 10,000 acres; and reduced-tillage systems programs in North Dakota that have contributed to the doubling of acres under such systems annually.

**Identifying Useful Genetic Variants for Crop Improvement:** Plants resistant to the toxin produced by the fungus *Helminthosporium victoriae*, which causes victoria blight in oats, were recovered from tissue cultures initiated from a susceptible oat line. All progeny of these plants were also resistant, indicating that the trait is heritable. This is the first example of the selection of a stably inherited trait in oats through the use of tissue cultures and one of the first examples in the cereal crops. This finding by ARS scientists further demonstrates the tissue culture approach for identifying useful genetic variants for crop improvement.

**Applicator Training Increases Safe Use of Pesticides:** The Extension Service, in cooperation with the Environmental Protection Agency, provides leadership for Pesticide Applicator Training Programs. State regulatory agencies certify applicators who successfully complete the training. Since its inception in late 1975, the program has trained more than 2 million applicators—about 90 percent of the potential audience. The program has also enhanced the awareness of farmers, Cooperative Extension, state governmental officials, and others about the importance of regulations and safe pesticide use. The Extension Service signed an agreement with EPA to develop a bilingual (English and Spanish) pesticide safety information program for farmworkers in cooperation with Florida's Cooperative Extension Service and Department of Education, Adult Migrant Program. Materials will be field-tested and evaluated for possible nationwide application.

**Soybean Cyst Nematodes Reduced by Double-Cropping:** The soybean cyst nematode is the most important pathogen on soybeans in the United States. Scientists at the University of Tennessee have discovered that soybean cyst nematodes can be reduced by double-cropping soybeans and wheat. Double-cropping with wheat decreased by 90 percent the number of juvenile nematodes—the form that invades soybean roots. This is comparable to results obtained using chemical control. The researchers believe the wheat roots may exude a substance that keeps the cyst nematode eggs from hatching. Thus, double-cropping with wheat using minimum tillage techniques not only reduces erosion but may also be an important factor in controlling the soybean cyst nematode.

**Increasing Efficiency of Nitrogen Fixation:** Biological nitrogen fixation is catalyzed by the enzyme nitrogenase, which also catalyzes an energy-wasting side reaction evolving hydrogen gas. However, some strains of *Rhizobium japonicum*—the bacteria which infects soybeans—have genes to synthesize another enzyme, hydrogenase, which can reoxidize hydrogen and conserve the energy. Oregon State University scientists have isolated DNA fragments containing the hydrogenase gene with the hopes of transferring this attribute to other Rhizobia. Scientists at Johns Hopkins have isolated mutant strains of *R. japonicum* that have higher levels of hydrogenase, but they have not been field tested.

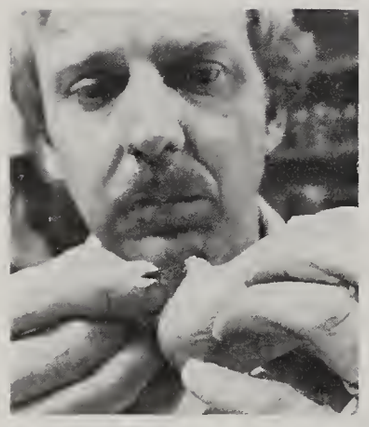


**Biological Control of Weeds:** Research to develop biological agents to replace potentially hazardous herbicides for controlling selected weeds in rice and soybean fields has been in progress for some time at the University of Arkansas. This work has now assumed even greater significance with the removal of the herbicide 2,4,5-T from the marketplace.

The researchers have found an indigenous anthracnose fungus that is a candidate for development and commercialization as the first microbial agent for selective weed control in these crops. The fungus has been formulated for spraying. When applied to fields via aircraft, it provides excellent control of the weed curly dock with no damage to crops or the environment. Curly dock is estimated to cost Arkansas rice growers $7.6 million annually if not adequately controlled.

**Corn Gene Bank Maintained:** More than 3,000 lines of corn are maintained at the North Central Regional Plant Introduction Station at Iowa State University. The station is a cooperative institution supported by the North Central State Agricultural Experiment Stations and the Agricultural Research Service of USDA. Plant breeders, geneticists, and molecular biologists from public and private institutions can secure needed genetic material for their research from the scientists of the Plant Introduction Station.

Extracting and combining genes is the basis of corn improvement, whether done by the hybridization and selection methods of the plant breeder or by the recombinant DNA techniques of the molecular biologist. A changing agriculture will require new attributes for crop plants. Genes for many of these attributes are now on reserve in this collection.



**Test for Detecting Viroids in Potatoes:** An inexpensive and extremely sensitive diagnostic test for the presence of viroids in potatoes has been devised by Agricultural Research Service scientists. This test is being used on a commercial scale in several countries to ensure disease-free seed potatoes. The new test is based on a reaction that occurs between the viroid present in plant sap and genetically engineered DNA. In another line of research on potato spindle tuber viroids, it has been shown that recombinant DNA clones, containing cDNA inserts of the viroid, are infectious. This research offers a basis for understanding host-pathogen interactions and allows construction of a complete genetic map of the viroid.

**Enzymes Associated With Vegetable Oil Synthesis Isolated:** Until recently, little was known about the detailed molecular structure of the enzymes responsible for synthesis of the important fatty acids in vegetable oils. Scientists at the University of California at Davis have isolated and purified all seven enzymes involved in the synthesis of palmitic and stearic acid components of the oils. As a result, several firms are trying to modify plants by recombinant DNA techniques so they will synthesize the precise combination of fatty acids needed for the edible oil industry.

## Animal Production and Protection

The Five Year Plan emphasizes long gestations, slow rates of maturation, and low prolificacy of farm animals as deterrents to rapid genetic progress. Thus, as with plants, basic biotechnology research offers great potential for more rapid genetic improvement. The Plan also emphasizes the substantial losses caused by animal diseases, parasites, toxicants, and inefficient reproduction and stresses the need for more attention to these industry problems.

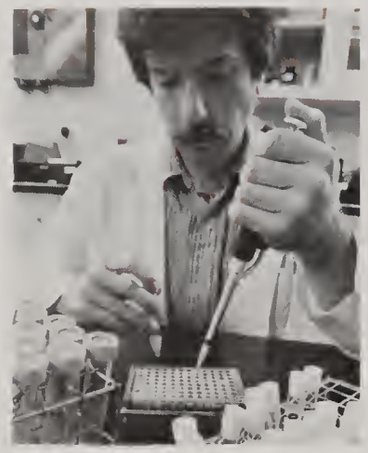
**Monoclonal Antibodies Control Poultry Parasites:** Coccidiosis, the most important parasitic disease of poultry, costs U. S. producers approximately $150 million each year from improper growth and feed utilization and another $90 million for medication.

Vaccines against this protozoan (single-cell animal) infecting the digestive tract are not available. Agricultural Research Service scientists are using monoclonal antibodies (hybridomas) to provide information needed for vaccine development.

Over 600 hybridoma cell lines have been developed that produce specific antibodies directed against various species and developmental stages of the parasite. These monoclonal antibodies have been used to study immunity, inhibition of penetration of host cells by the parasite, dynamics of parasite/antibody interactions, and diagnosis. A memorandum of understanding has been established with three commercial companies, whereby they will genetically engineer specific coccidial antigens using monoclonal antibodies developed and supplied by ARS.

**Engineering Disease-Resistant Animals:** Recent breakthroughs in genetic engineering make possible the production of disease-resistant animals. Scientists in six states (California, Iowa, New York, Texas, Washington, and Wisconsin) are mapping the location of livestock and poultry genes which control resistance to specific diseases.

Colorado scientists have developed methods for nonsurgical collection and transfer of embryos and for freezing and storing them. They have also researched techniques for dividing embryos into two or three pieces to produce identical twins or triplets. Additional procedures which will permit more rapid propagation of disease-resistant animals include development of methods to sex embryos and techniques for microsurgery in the developing embryo. When these techniques are perfected, it will be possible to insert genes for important economic traits into embryos and then propagate genetically superior animals.



**New Test for Rapid Diagnosis of Livestock and Poultry Diseases:** Reliable, fast, and relatively inexpensive new diagnostic procedures for animal diseases are being used for the rapid detection of viral, bacterial, and parasitic agents. These tests are called enzyme-linked immuno assays (ELISA) and can be used to detect animal diseases such as bovine rhinotracheitis, bovine viral diarrhea, infectious bronchitis (chickens), and cysticercosis.

ELISA tests make it possible to detect the causative agents of disease much more rapidly and more simply—resulting in more efficient treatment of the diseases. These procedures have proven extremely useful in studies to determine the routes of infection and the actual vectors of many diseases. Scientists in 18 states are conducting research on ELISA. This general approach represents a major breakthrough in the ability to diagnose the causes of disease and understand how disease agents operate.

**Beef Production Efficiency Improved:** Improving efficiency is one key to surviving in the competitive beef industry. Beef producers can become more efficient by increasing calving percentages and calf-weaning weights. Extension personnel in Arkansas have used on-farm demonstrations and cattle producers' meetings to promote improved management practices in the 39 counties which produce 60 percent of the state's beef cattle. Two management practices which have been encouraged are performance testing of breeding stock and use of implants. Increased calving percentages and weaning weights brought about by adoption of these management practices are valued at $3.5 million annually.

Preconditioning of feeder calves in Nebraska and South Dakota has been promoted as part of a management system which includes a sound marketing strategy. Gains from adopting such practices are estimated to range from $28 to $50 per calf.

**Sexing of Embryos Before Transfer:** One shortcoming of embryo transfer technology has been the inability to identify the sex of the offspring until pregnancy is well established. In livestock (e.g., dairy cattle) one sex is often of greater value than the other. California scientists have developed a procedure for early identification of the sex of embryos, using an antibody technique. The accuracy of the procedure is approximately 85 percent.

Research dairy herds of genetically identical animals greatly reduce the number of animals needed for certain types of experiments and thus reduce research costs. Scientists are investigating procedures for splitting cattle and sheep embryos to produce genetically identical twins. One laboratory has produced identical quintuplets from a single sheep embryo. This technology will be useful for increasing the number of offspring from valuable females and will provide a potent research tool for separating genetic and environmental effects.

**Culling/Replacement Strategy Increases Returns:** A large portion of the beef industry consists of "cow-calf" operations, which can be victims of the severe cyclical patterns in beef prices. To improve producers' decisionmaking ability, Oklahoma agricultural

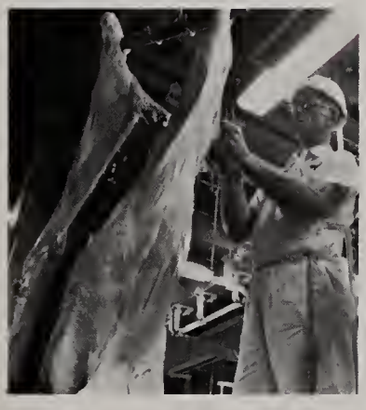
experiment station scientists have used a combination of systems modeling, optimal control theory, and asset replacement theory to develop guidelines for culling and replacements for cow herds based on the price cycle. The model describes a recommended set of culling ages and herd sizes over a typical cattle price cycle.

An individual producer can increase his returns an average of 10 to 15 percent per year using this system. Culling age may vary from 6 to 12 years, while replacement rate varies between 8 and 40 percent per year. Herd size, in the meantime, need not vary more than 15 percent and can be controlled by other variables such as feed supply. This model can be useful to cattle producers nationwide with very little modification.

**Residue Avoidance Program:** A recent poll showed that 77 percent of Americans consider residues in food a serious health threat. The Extension Service and the Food Safety and Inspection Service, with the help of the National Agricultural Library, successfully launched a continuing cooperative effort to educate livestock and poultry producers on proper animal drug use in order to help them avoid illegal drug and chemical residues in their slaughtered animals. Thirty-one State Cooperative Extension Services are involved in 37 projects, which include publications, residue hotlines, surveys of drug and pesticide use, exhibits, and slide sets.

## Processing, Marketing, and Distribution

Processing, marketing, and distribution is that sector of the agricultural and food system that exists beyond the farm gate. The Joint Council's Five Year Plan states that this sector of the U.S. economy will become increasingly critical to maintaining national employment, controlling inflation, and improving balance of payments. Both the FY 1985 Priorities Report and the Five Year Plan stress the importance of foreign markets for U.S. farm products.



**Restructuring Meat Products Adds Value and Acceptance:** Scientists at South Dakota State University are developing technology for restructuring meat products. Chunked and formed "steaks", the second generation of restructured meat products, contain much larger lean particles than the earlier flaked products. They more closely simulate the texture of intact-muscle steaks such as the T-bone or sirloin. The objective of restructuring is to offer the consumer a product of intermediate value and quality between ground beef and steak. The capacity for exact control of composition and portion size makes these products desirable to the hotel, restaurant, and institutional trade.

The eating quality of lower valued meat cuts, such as the chuck, can be dramatically improved through such processes. Restructured steaks that are 88 percent lean can be retailed profitably at twice the price of boneless chucks. Commercial production of restructured meats in the United States was estimated at 200 million pounds in 1981. This volume is expected to increase substantially over the next decade.

**Microbiological Research Improves Food Safety and Quality:** Food products are undergoing constant product and process modifications, so preservation and fermentation processes need to be re-evaluated frequently. Basic research on spore physiology and lactic acid bacteria genetics permits more informal decisions to assure safety and improve quality.

Controlling undesirable sporeforming microorganisms is necessary to assure safety in the home, in food service, and in commercial food processing. Research on controlling sporeformers includes such topics as: alternatives for nitrites and other food additives, effects of acidification on sporeformers, growth and death of spores during long, low-temperature cooking, and safety evaluations for new food cooking and cooling regimens.

Microorganisms are involved in many food manufacturing processes. Minnesota Agricultural Experiment Station scientists have applied genetic engineering technology to improve lactic acid bacteria for specific fermentation processes that improve food products. Widespread use of the findings has resulted in improvements in efficiency of production, flavor, texture, shelf-life, appearance, and nutritional quality of the final products.

**Commodity Options—A New Marketing Alternative:** The agricultural community gained the use of a new marketing tool in the fall of 1984. The 1982 Futures Trading Act lifted the 1936 ban on options trading and authorized the Commodity Futures Trading Commission (CFTC) to conduct a limited test. Options enable producers, processors, traders, and others to establish a price floor or ceiling on commodities they wish to sell or buy. Options contracts are similar to futures contracts, but are sufficiently different from them to require a major educational effort.

The Extension Service-USDA cooperated with the CFTC and the commodity exchanges to conduct educational programs for the industry. Extension developed an educational package and held regional in-service training workshops for state Extension specialists. The specialists, often in cooperation with CFTC and commodity exchange personnel, trained producers, processors, grain elevator operators, and others.

## Agricultural Policy

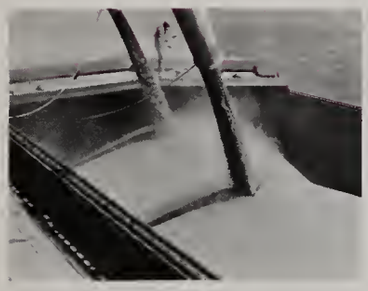
The FY 1985 Priority Report of the Joint Council states the need for longer-term anticipatory policies that meet society's interests in stability for the agricultural economy. The report suggests that trade barriers, micro-economic factors, and the effect of changing export marketing practices on American exports need to be examined. One goal of the Five Year Plan is to develop natural resources policy alternatives that interact favorably with other policies related to the environment—both physical and social.

**Consistency Between Commodity Programs and Soil Conservation:** The relationship of USDA's commodity programs and related farm programs to its soil conservation objectives was the subject of a study by three USDA agencies (Economic Research Service, Agricultural Stabilization and Conservation Service, and Soil Conservation

Service). The purpose of the study was to determine whether soil erosion might be decreased through better coordination between these two areas of USDA responsibility, which sometimes work at cross purposes. Findings indicate that program changes would affect one-third to one-half of the U.S. cropland that is eroding at excessive rates, because the operators are already participants in one or both programs.

**Conservation Benefits of Acreage Reduction Programs:** A joint ERS-ASCS study shows that diverting cropland for the primary purpose of controlling oversupply of agricultural commodities can have significant soil conservation benefits. The 1983 Payment-In-Kind and Acreage Reduction Programs reduced soil movement by over 135 million tons or almost 2 tons for every acre removed from production. All cover types, except fallow, showed significant soil savings. The programs also achieved significant wildlife benefits and conserved water through reduced irrigation.

**International Trade Affected by Debt Problems:** An ERS study found that international trade will be adversely affected by the debt problems of the developing countries for at least the next 5 years. Any significant increase in trade between the United States and these countries will be realized only when aggressive actions are taken by both the developed and developing countries to overcome the debt problem. The debt problem is concentrated in a few countries, particularly the middle-income oil importers, Latin America, Eastern Europe, and non-oil-producing North African countries.



**Developing Countries Need Sizeable Grain Imports:** A recent ERS analysis details the food assistance needs of 67 food-deficit developing countries for 1984/85 and 1985/86. Estimates were made of food aid needed to sustain recent levels of per capita food availability and to meet internationally accepted minimum nutrition standards. The analysis included both total import requirements and the share of these that countries cannot afford to purchase commercially. These countries—given projected weather and financial conditions—will need to import nearly 31 million tons (grains equivalent) in 1984/85 to maintain existing food availability.

## People and Communities

Several important needs are grouped under this heading. The Joint Council's Priority Report identified "Human Nutrition, Including Food Safety and Quality" as one of the top eight national priorities for FY 1985. It also includes "Communications Technology" in this list. The Five Year Plan identified "Youth, Family, and Consumer Programs" and "Community and Rural Development" in its list of key subject-matter categories.

**Purified Dietary Fibers Lower Blood Cholesterol:** Considerable interest exists in the relationship between high levels of serum cholesterol and heart disease. Diets that lower blood cholesterol without producing any adverse side effects are frequently recommended. A study sponsored by ARS showed that a number of purified dietary fibers, when added to the normal American diet, lowered blood cholesterol in men after 4 weeks. The effective fibers all had the property of forming gels in solution. No undesirable effects of these fibers were observed, such as loss of trace elements from the body. The results indicate that the inclusion of gelling fibers in the diet may be a safe means of lowering blood cholesterol levels.

**Food Preservation Encouraged:** Rising costs of processed foods, changes in the labor force, and a rise in the number of first-time canners—all have increased the need for food preservation and safety information. In Arkansas, the food preservation program provided by the Cooperative Extension Service emphasizes methods of food preservation which result in extending the food supply, increasing buying power, conserving the nutritive value of foods, and expanding the variety of foods in diets. More than 30,000 families received food preservation information through fact sheets and point-of-purchase demonstrations. Surveys revealed that many former canners corrected processing methods at an estimated saving of more than $13 million. In Oklahoma, 1,500 volunteer leaders were trained and more than 255,000 people were reached through food preservation and safety programs.


**Food and Fitness Campaign Promotes Better Health:** An important USDA activity is its nationwide Food and Fitness campaign. The campaign stresses the importance of good nutrition, emphasizes the importance of diet and exercise to health, and promotes continuation of the high-quality American food system. The Cooperative Extension staff coordinates state and local participation in the Food and Fitness campaign by providing a wide variety of activities for people at all levels. Alabama alone reported over 500 meetings in a 3-month period reaching approximately 14,000 people; 44 exhibits with over 72,000 viewers; more than 300 radio spots, 300 news articles, and 12 television spots.

In Kentucky, diet and health programs reached nearly 60,000 people through direct contact, and surveys of behavior changes indicated that 89 percent of program participants had made at least one change in their diets.


**Farm Financial Management:** Farm families are receiving training to help them cope with financial problems. Financial management programs developed by the Cooperative Extension Service help producers prepare and analyze cash flow and other financial statements. They also help with organizing farm enterprises and making effective marketing decisions. Intensive workshops present the use of computerized financial management techniques and various methods of analyzing individual situations so that farmers can make good decisions.

More than 5,000 farmers in Minnesota and Illinois have received individual assistance in analyzing financial problems and in preparing plans to deal with these problems. South Dakota farmers who were assisted in preparing farm financial plans are expected to have a substantial increase in annual income. More than 1,500 farmers in the state of Washington received intensive assistance, and over 1,000 farm families in southern Iowa were helped after the 1983 drought.

**Outlook Network Provides Timely Market Information:** Extension has improved its outlook programs by providing better and more timely analyses. Price variability and uncertainty in agricultural markets has increased over the last 15 years. To facilitate agricultural product marketing, the Extension Service obtains pertinent information from several USDA agencies and makes it available electronically to Extension specialists within an hour of release through its Computerized Outlook Information Network (COIN) system. State specialists retrieve and adapt the information to local situations and make their analyses available to producers and others via codaphones, radio, TV, and state computerized videotext networks. They also distribute newsletters and write articles for trade papers and newspapers.

In the 1980's, Extension publications have presented the variability of production and price estimates to help clientele appreciate the risks involved in forecasting. Educational programs for Extension specialists on risk-rated decisionmaking are now underway.

**Computer Model Aids Soil-Crop Management Decisions:** ARS scientists have developed a coordinated farm and research management system (COFARM) for making soil-crop management decisions regarding N, P, and K fertilizer needs, manure, tillage, crop residues, soil erosion, drainage, and crop yields. The computer program is user-friendly and can be operated from a remote terminal or microcomputer. Extension agents and researchers can use the system and the information collected through its use, either directly or with an existing submodel or other models. Farmers can use the system to organize and store data for their individual fields, soils, and crops.

**Leadership Developed Through 4-H:** Through its 4-H Program, the Cooperative Extension system provides knowledge and skills to more than 4.6 million of tomorrow's leaders. Participants are between the ages of 9 and 19 and reside in every demographic area ranging from farms to cities. In Washington, D.C., 23,000 youth participated in leadership development activities. Over 325 volunteers devoted both resources and 32,500 hours of their time to help the young people improve their leadership qualities and in turn improve the quality of life of other Washington, D.C., citizens. Last year, 460 4-H youth in five South Dakota counties explored career options through AGNET, a computer-assisted program. The Jobsearch program was implemented to match the user's self-inventory of interests and abilities with possible occupations.

More than 19,600 4-H'ers are involved in computer projects nationwide. Kentucky leads the enrollment with over 14,000 participants. Over 19,000 Utah youth have participated in the 4-H Voter Awareness Program during the past 5 years. Last year, 43 4-H clubs in 26 states were awarded citizenship-in-action grants for innovative citizenship and community involvement projects and programs.

**Community Economic Development:** Small communities face the double bind of unemployment and a reduced tax base when industrial plants shut down. Teaching community leaders to deal with shutdowns and developing seminars for small business operators are examples of Extension community development programs.

Community action teams in Utah developed a systematic approach for four communities to mobilize resources to deal with shutdowns. Through publications, seminars, and mass media, 450 community leaders, company and union officials, and 30,000 workers throughout the state have benefited from the program.

In Michigan, statewide workshops on starting a small home business involved 50 counties and 2,470 persons. Forty-nine percent of those attending began new businesses with an average investment in each business of about $5,000. Over $6 million was invested in the Michigan economy and $378,000 in sales was added monthly as a result of this program.

# IV. Accomplishments of the Joint Council, National Committees, and Regional Councils

## Joint Council

**Needs Assessment Prepared and Distributed:** A major activity of the Joint Council over the past year was to help the Secretary of Agriculture prepare a Needs Assessment for the Food and Agricultural Sciences. The Needs Assessment provides a conceptual framework for planning, coordination, and allocation of resources in the food and agricultural sciences.

The Needs Assessment was not only submitted to Congress, but also distributed to land-grant and non-land-grant institutions, USDA agencies, non-USDA federal agencies, industry, professional societies, commodity organizations, and the media.

A 12-minute slide/tape presentation based on the Needs Assessment was prepared and distributed to Deans of Agriculture and USDA agency administrators. The presentation was also made available in a video tape format.

The Needs Assessment has generated considerable interest. Favorable comments have been received from within the food and agricultural system and also from many people outside the system.

**Five Year Plan Prepared and Distributed:** The Five Year Plan for the Food and Agricultural Sciences, completed in May 1984, is a conceptual plan derived from the problems identified in the long-term needs assessment. It lists, by subject-matter and special categories, long-range goals to solve these problems, short-range objectives to attain the goals, and the present and projected resource allocation. The Five Year plan provides a standard for evaluating progress, a planning aid for decisionmakers, and an accounting of resource allocation. The Plan was also widely distributed.

**FY 1986 National Priorities for Research, Extension, and Higher Education Published:** The Joint Council selected and ranked national priorities for Research, Extension, and Higher Education. Input to this process was provided by the Regional Councils and National Committees of the Joint Council, involving state, regional, and national considerations. The Joint Council selected and ranked nine national priorities for FY 1986 and submitted them to the Secretary of Agriculture.

**Major Topics Considered:** The Joint Council included several major topics of interest on its agenda during the year for discussion and development of recommendations. The topics included:

- Non-Land-Grant Institutions—The role of non-land-grant institutions in food and agriculture teaching, research, and information dissemination was discussed. The linkage among these functions and with the land-grant institutions was considered.

- 1890 Institutions and Tuskegee Institute—A panel discussion focused primarily on: (1) the role of 1890 institutions and Tuskegee Institute in teaching, research, and information dissemination; (2) linkages among teaching, research, and information dissemination within 1890 institutions and Tuskegee Institute, and (3) linkages with 1862 institutions.

- Forestry in the Future—The general objective of the session was to relate forestry to the national agenda implied by the "Needs Assessment for the Food and Agricultural Sciences."

- Soil and Water Conservation—Soil and water conservation issues and concerns were related to agricultural production, including the off-site, off-farm effects of soil erosion.

- International Dimensions of Food and Agricultural Programs—The Joint Council and the International Science and Education Council (ISEC) jointly planned and conducted a session on international coordination and cooperation. The session provided an economic setting and rationale for U.S. involvement in international activities. An overview of the missions and roles of USDA agencies, the Agency for International Development (AID), universities, and private industry were presented. Mechanisms for collaboration and cooperation and sources of funding for international activities were outlined.

- Relationship Between Food and Agriculture Issues/Concerns and Joint Council Reports and Activities—Both Congressional oversight hearings on research, extension, and teaching and other major studies have raised several issues and made some suggestions concerning the Joint Council activities. Suggestions included: (a) refine priorities into more specific terms to help drive general priorities into a specific plan of action, (b) account for non-scientific factors which affect the demands being placed upon research, extension, and teaching, e.g. economic factors, (c) consider broad social and regulatory actions affecting the course of agriculture, such as concerns with personal well-being and changes in diet, and (d) be aware of the food- and agriculture-related research and education activities in other federal agencies.

The Joint Council addressed the above concerns and developed recommendations for response.

## National Agricultural Research Committee

National Agricultural Research Committee priority areas for agriculture and forestry initiatives for FY 1986 were developed by revising or extending those established for FY 1985. After the committee ranked 22 topics, basic research, water management, sustaining soil productivity, and cropping and pest management systems research were given highest priority.

Activities of all standing subcommittees were reviewed and evaluated. As a result, the charges of two subcommittees—"Steering Committee on Technology Assessment" and "Long-term and Strategic Planning"—were judged to be fulfilled. These were therefore discontinued.

The Committee discerned an urgent need to develop a firm schedule for conducting and refining the biennial research projections, as a way to respond to Joint Council needs. Projections will continue to be made every 2 years, using the assumptions (1) no increase in funding, and (2) a 20-percent increase in funding.

The Task Group on "Basic Research and Agriculture" developed a draft of a brochure entitled "Basic Research for Agricultural Progress". The draft is undergoing final review and refinement.

**National Higher Education Committee**

The Higher Education Committee met twice in 1984 to deal with the problems of communicating the accomplishments, needs, and priorities of the broad areas of agriculture, home economics, veterinary medicine, and forestry. Each area has special needs and problems as well as those that are expressed as overall needs and problems.

There is continuing concern about attracting high-quality undergraduate students. Enrollments are declining nationwide and it appears that the graduates needed to meet the projected demands of a high-technology agricultural industry will not be available. The committee will be developing projects to (1) improve the image of the broad array of disciplines comprising the food and agricultural sciences in order to attract quality students, (2) emphasize opportunities for students interested in agri-business and agri-science careers, (3) utilize more fully all aspects of the agricultural system in delivering information to the public about the opportunities for bright students in agriculture.

The committee plans to develop a task force to secure data to document the needs of the teaching community. Data are needed concerning equipment, laboratory facilities, faculty development, and curricula. These problems have been identified as a priority item for higher education in agriculture. This information is needed to support the needs for strengthening grants.

Examples of changes and initiatives in Higher Education in the Food and Agricultural Sciences:

(1) In all areas, the use of computers is progressing rapidly. In addition to training in computer operations, computers are being used in courses involving problemsolving, decisionmaking, information retrieval, and simulation modeling.

(2) State-of-the-art equipment for instrumentation training in undergraduate and graduate laboratories is increasingly important. This type of training is vital and progress is being limited by inadequate funding for equipment. Increased instrument training is a major concern in veterinary medicine.

(3) Audiovisual and video training techniques are being used to complement the use of laboratory animals wherever possible.

(4) Increased emphasis on internships, practicums, and cooperative education is occurring in all areas. The involvement of business, industry, and government in these programs is increasing. The growing employment of home economics graduates in business and industry is providing a stronger link between higher education and business and industry.

(5) Considerations of public policy, public purpose, ethics, and social concerns are being incorporated into courses. For example, concerns of water usage and public lands are being addressed in the western region.

(6) The education committee of the National Association of Professional Forestry Schools and Colleges and the Society of American Foresters is discussing the status and future of professional forestry education.

**National Extension Committee**

The National Extension Committee actively examined issues affecting Extension, contributed to and supported Joint Council reports, and reviewed Extension-related studies. Linkages between Extension and other federal/state agencies and commodity organizations were examined through special presentations and discussions. A survey was conducted to identify extension-type activities carried out by non-land-grant institutions. In a combined meeting with the Joint Council, members participated in panels on the role of 1890 institutions and their linkages with 1862 institutions, and on the role of non-land-grant institutions and their linkages.

The Committee implemented a systematic process for assembling, developing, and ranking Extension priorities used in preparing the Joint Council's Priorities Report. Input was solicited from across the Extension system and from lay groups and commodity organizations. Extension priorities were reviewed, summarized, and ranked by the NEC and submitted to the Joint Council.

Preliminary findings from the "Study of Needs and Opportunities To Strengthen Extension's Research Base" were discussed. The Committee participated in development of the Joint Council's Needs Assessment Report and Five Year Plan through review and preparation of supplementary material.

**Northeast Regional Council**

The Northeast Regional Council (NeRC), working through the regional functional committees, established 16 regional priorities with accompanying statements. These were submitted to the Joint Council for inclusion in the 1986 Priorities Report.

After a 1-year lapse, the Council reactivated its Extension and Higher Education Committees and established committee goals and objectives for 1985. The Northeast Agriculture Research Committee has reexamined its goals and objectives and has recommended revised operational procedures designed to focus more activity on high priority regional research programs.

The NeRC's Steering Committee for "Project 2005" has published the Project Statement and has appointed task force chairmen and an executive director for the project. Project 2005 is designed to identify critical issues and alternative courses of action to help assure a desirable future for Northeast food, agriculture, and forestry industries. Project headquarters has been established at the University of Delaware through a cooperative agreement with the Council. Project operations officially began on October 1, 1984. Completion is scheduled for April 1986.

Northeast Regional Council meetings during the past year have provided Council members an overview of the research and educational programs of the USDA Nutrition Center, Tufts University, and the National Arboretum.

**Western Regional Council**

Two major interests of the Western Regional Council (WRC)—water and rangeland—were pursued in 1984. WRC received and reviewed a preliminary report on rangeland from the Western University Range Extension Committee and a Western Regional Coordinating Committee (Western Rangeland Research). The report assesses current research and extension efforts and projects research and extension needs for the year 2000. The report complements similar studies undertaken by the Forest Service and the Agricultural Research Service. Before taking action on the assessment, WRC asked that a special committee develop a covering report which emphasizes major issues; consolidates State Agricultural Experiment Station (SAES), Extension, and federal projections; and includes pertinent economic data.

A pilot project undertaken in 1983 and involving research planning on water, the region's top priority, is nearing completion. At the request of WRC, the Western Agricultural Research Committee (WARC) appointed a special task force to study research needs and determine if one or more problem definition plans could be developed. The panel developed a report which is now being reviewed by SAES and federal administrators.

In response to a request from the Joint Council, the Western Regional Council reviewed priorities for FY 1986. The Council reaffirmed its FY 1985 priorities, while emphasizing that teaching, extension, and research are all involved in almost every item. The Council specifically did not include basic research as a separate priority, feeling that most research subjects contain elements for fundamental study as well as applied research.

Recognizing the necessity of looking ahead at the changing needs in order to make more accurate projections of year-by-year priorities, WRC has asked its three functional committees to start considering priorities for the next 5 years. These reports will be the primary focus for discussion at the winter meeting of the Western Regional Council.

Finally, WRC has been working to improve understanding of and communications among the performers, as well as between performers and users, in the food and agricultural system.

## Appendix 1

### Joint Council Priorities for Research, Extension, and Higher Education and Five Year Plan Categories

| FY 1985 Priorities[1] | Five Year Plan Categories[2] |
|---|---|
| | **Subject-Matter Categories** |
| Basic Biotechnology Research | |
| Scientific Expertise Development | |
| Communications Technology | Soil, Water, and Air |
| Analysis of Price and Income Policies With Emphasis on Five Year Trade | Forest, Range, and Wildlife |
| | Crop Production and Protection |
| Sustaining Soil Productivity | Animal Production and Protection |
| Human Nutrition, Including Food Safety and Quality | Processing, Marketing, and Distribution |
| | Agriculture and Resource Policy |
| Water Management | Human Nutrition |
| Forest, Range, and Pastureland Productivity Enhancement, Including Multiple Use | Youth, Family, and Consumer Programs |
| | Community and Rural Development |
| | International Science and Education Programs |
| | **Special Categories** |
| | Scientific Expertise in Agriculture |
| | Biotechnology in Agriculture |
| | Information Systems and Communication Technology |
| | Equipment and Facilities |

[1] From "FY 1985 Priorities for Research, Extension and Higher Education. A Report to the Secretary of Agriculture". June 30, 1983. 37 pp.
[2] From "Five Year Plan for the Food and Agriculture Sciences. A Report to the Secretary of Agriculture." May 1984. 67 pp.

## Appendix 2

### The U.S. Food and Agriculture Science and Education System

**Cooperative State Institutions:**

- Land-grant colleges or universities in each state as authorized by Act of 1862, plus 16 colleges of 1890 and Tuskegee Institute, have programs of higher education in food and agricultural sciences.

- Fifty-eight State agricultural experiment stations (many with networks of substations) plus 16 schools of forestry, plus certain schools of home economics and veterinary medicine conduct research programs partially supported by federal formula funds. Research investment (all sources) was $1,097 million in FY 1983 involving 7,576 scientist years (SY) of research effort.

- Cooperative Extension Services exist in all 50 states plus the District of Columbia and U.S. territories. With total funding at approximately $935 million last year, Cooperative Extension programs involved almost 17,000 professional staff years, plus nearly 5,500 paraprofessional staff years, plus significant inputs by over 1.5 million volunteers trained and supervised by professional staff.

**Other Colleges and Universities:**

- Approximately 200 other state-supported colleges or universities conduct programs of higher education, research, and outreach in food and agricultural sciences.

**USDA Research/Education Agencies:**

- The Agricultural Research Service allocated $502.5 million in FY 1984. Research is conducted at 146 locations in the United States and abroad involving 2,850 SY's.
- The Cooperative State Research Service channels most of its funds—$248 million in FY 1984—to the cooperating State research system on a formula basis; it also includes competitive and special research grants and federal administration.
- The Extension Service, with funding of $334 million in FY 1984, channels most of its funds to the Cooperative Extension system; it also includes federal administration.
- The National Agricultural Library, funded at $10.4 million in 1984, provides wide-ranging library and technical information services.
- The Economic Research Service, with funding of $46 million for FY 1984, accounts for about 500 SY's of economic and social science research and analysis.
- The Forest Service (research divisions), with funding of $109 million in FY 1984, provided about 800 SY's of research in resource management and utilization plus resource protection functions.
- The Office of Grants and Program Systems administered a $17 million Competitive Research Grants program in Small Business Innovative Research, and some cross-cutting programs of Science and Education. The Office of Higher Education directs programs designed to strengthen scientific and professional expertise.

- Other USDA agencies have limited but direct R&E roles:

Office of International Cooperation and Development
Soil Conservation Service
Agricultural Marketing Service
Office of Transportation
Agricultural Cooperative Service
Statistical Reporting Service

**Other Federal Agencies:**

- At least 14 federal departments, commissions, and independent agencies besides USDA conduct research and education programs closely related to agriculture and forestry or provide funds to support programs in the USDA-state system. Total funding for such programs in FY 1983 is estimated at approximately $700 million.

**Private Firms:**

- Research and development (R&D) are performed by equipment, seed, fertilizer, and other input suppliers; producing, processing and distributing operations; and specialized private R&D firms. No hard data on total funding or specific personnel are available. (Recent estimates of food and agricultural research conducted by private firms were approximately $2.5 billion, larger than the USDA-state research system funding.)
- Technical information dissemination similar to some functions of Extension is performed by field personnel or buyers of farm commodities, dealers of farm inputs, and trade journals or publications including the farm press and specialized technical information or consulting firms.

**Other Private Organizations:**

- Foundations and similar organizations facilitate or channel funds to research and/or education programs in the public sector. Funding from these sources is estimated at $20 million annually.
- Associations formed by private firms conduct research and/or educational programs for their members.

## Appendix 3

### Joint Council on Food and Agricultural Sciences Membership List

Anderson, James H. (Cochair)
Vice Provost and Dean, College of Agriculture and Natural Resources
Michigan State University
East Lansing, MI 48824

Bentley, Orville G. (Cochair)
Assistant Secretary
Science and Education
U.S. Department of Agriculture
Room 217-W, Administration Building
Washington, D.C. 20250

Buckman, Robert E.
Deputy Chief for Research
Forest Service, USDA
Rm. 3007, South Building
Washington, D.C. 20250

Carter, Lark P.
Dean, School of Agriculture
California Polytechnic State University
San Luis Obispo, CA 93407

Coulter, K. Jane
Director, Higher Education Programs
Agricultural Research Service, USDA
Rm. 350-A, Administration Building
Washington, D.C. 20250

Curtin, Terrence M.
Dean, School of Veterinary Medicine
North Carolina State University
Raleigh, NC 27650

Edwards, Jeanne
Users Advisory Board Representative
240 Westerly Road
Weston, MA 02193

Fischbach, Andrew M.
Box 159
Faith, ND 57626

Greenwood, Mary Nell
Administrator, Extension Service
U.S. Department of Agriculture
Rm. 340-A, Administration Building
Washington, D.C. 20250

Howard, Joseph H.
Director
National Agricultural Library
U.S. Department of Agriculture
Rm. 109-A, NAL Building
Beltsville, MD 20705

Hurst, Robert L.
Vice President for Research and Extension
South Carolina State College
P.O. Box 1765
Orangeburg, SC 29117

Johnsrud, Myron D.
Director
Cooperative Extension Service
North Dakota State University
Fargo, ND 58105

Jordan, John Patrick
Administrator, Cooperative State Research Service
U. S. Department of Agriculture
Rm. 304-A, Administration Building
Washington, D.C. 20250

Kendrick, Edgar L.
Administrator, Office of Grants and Program Systems
U. S. Department of Agriculture
Rm. 324-A, Administration Building
Washington, D.C. 20250

Kincaid, David R.
Acting Director
International Research Division
Office of International Cooperation and Development
U.S. Department of Agriculture
Rm. 4200, Auditors Building
Washington, D.C. 20250

Kinney, Terry B.
Administrator, Agricultural Research Service, USDA
Rm. 302-A, Administration Building
Washington, D.C. 20250

Lee, J. Charles
Head, Department of Forest Service
Texas A&M University
College Station, TX 77843-2135

Lee, John E.
Administrator, Economic Research Service, USDA
Rm. 448, GHI Building
500 12th Street, S.W.
Washington, D.C. 20250

Little, C. Oran
Associate Director
Experiment Station
University of Kentucky
Lexington, KY 40546-0091

Luck, John V.
Senior Vice President
General Mills, Incorporated
James Ford Bell Technical Center
9000 Plymouth Avenue North
Minneapolis, MN 55427

Lund, H. Roald
Dir., Agricultural Experiment Station
North Dakota State University
Box 5435, State University Station
Fargo, ND 58105

Mawby, Russell G.
Chief Executive Officer
W. K. Kellogg Foundation
400 North Avenue
Battle Creek, MI 49016

Moline, W. J.
Director, Cooperative Extension Service
University of Arkansas
P.O. Box 391
Little Rock, AR 72203

Myers, Peter C.
Chief, Soil Conservation Service
U.S. Department of Agriculture
Rm. 5105, South Building
Washington, D.C. 20250

Owen, Robert R.
President, The Eversman Mfg. Co.
1145 Fifth Street
P.O. Box 4345
Denver, CO 80204

Oyer, Edwin B.
Director
International Agriculture Program
Cornell University
Ithaca, NY 14853-0332

Pettibone, C. Alan
Associate Dean
College of Agriculture
Washington State University
Pullman, WA 99164

Sledge, George W.
Associate Dean & Director
Academic Affairs, College of Agricultural & Life Sciences
University of Wisconsin
Madison, WI 53706

Treat, Kathryn R.
Assistant Director
Cooperative Extension Service
New Mexico State University
Las Cruces, NM 88005

Walker, Melvin E.
Research Director
Division of Agriculture
Fort Valley State College
P.O. Box 5744
Fort Valley, GA 31030

Wefald, Jon
Chancellor
Minnesota State University System
230 Park Office Building
555 Park Street
St. Paul, MN 55103

Young, Alvin L.
Senior Policy Analyst
Office of Science & Technology Policy
Rm. 5005, New Executive Office Building
Washington, D.C. 20500

**Executive Secretary to the Joint Council:**
Miller, Larry R.
Joint Council on Food and Agricultural Sciences
U.S. Department of Agriculture
Rm. 321-A, Administration Building
Washington, D.C. 20250

## Appendix 4

### National Committee and Regional Council Chairs

**National Agricultural Research Committee**
Dr. Keith A. Huston (Cochair)
North Central Agricultural Experiment Station Directors
Ohio Agricultural Research and Development Center
Wooster, OH 44691

Dr. Terry B. Kinney (Cochair)
Agricultural Research Service
U. S. Department of Agriculture
Washington, DC 20250

**National Extension Committee**
Mrs. Marianne Houston (Chair)
27 Lynnewood Road
Laconia, NH 03246

**National Higher Education Committee**
Dr. Sumner A. Griffin (Chair)
Dean, School of Agriculture
Tennessee Technological University
P. O. Box 5034
Cookeville, TN 27607

**North Central Regional Council**
Dr. T. E. Hartung (Chair)
Dean, College of Agriculture
University of Nebraska
Lincoln, NE 68583

**Northeast Regional Council**
Dr. Dale W. Zinn (Cochair)
Agricultural and Forestry Experiment Station
West Virginia University
Morgantown, WV 26506

Dr. Denver Burns (Cochair)
Northeast Forest Experiment Station
370 Reed Road
Broomall, PA 19008

**Southern Regional Council**
Dr. George J. Kriz (Chair)
Assistant Director
Agricultural Experiment Station
North Carolina State University
Raleigh, NC 27650

**Western Regional Council**
Dr. H C Cox (Chair)
Acting Deputy Administrator
Agricultural Research Service, USDA
133 Broadway, Suite 400
Oakland, CA 94612

## Appendix 5

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